

CLAIMS:

1. A processor module comprising:
at least a first integrated circuit functional
element including a programmable array; and
5 at least a second integrated circuit functional
element stacked with and electrically coupled to said
programmable array of said first integrated circuit
functional element.
2. The processor module of claim 1 wherein said
10 programmable array of said first integrated circuit
functional element comprises an FPGA.
3. The processor module of claim 1 wherein said
processor of said second integrated circuit functional
element comprises a microprocessor.
- 15 4. The processor module of claim 1 wherein said
second integrated circuit functional element comprises
a memory.
5. The processor module of claim 1 further
comprising:
20 at least a third integrated circuit functional
element stacked with and electrically coupled to at
least one of said first or second integrated circuit
functional elements.
6. The processor module of claim 5 wherein said
25 third integrated circuit functional element comprises
a memory.
7. The processor module of claim 1 wherein said
programmable array is reconfigurable as a processing
element.

8. The processor module of claim 1 wherein said first and second integrated circuit functional elements are electrically coupled by a number of contact points distributed throughout the surfaces of said functional elements.

9. A reconfigurable computer system comprising:
a processor;
a memory; and
at least one processor module including at least a first integrated circuit functional element having a programmable array and at least a second integrated circuit functional element stacked with and electrically coupled to said programmable array of said first integrated circuit functional element.

10. The computer system of claim 9 wherein said programmable array of said first integrated circuit functional element comprises an FPGA.

11. The computer system of claim 9 wherein said processor of said second integrated circuit functional element comprises a microprocessor.

12. The computer system of claim 9 wherein said second integrated circuit functional element comprises a memory.

13. The computer system of claim 9 further comprising:

at least a third integrated circuit functional element stacked with and electrically coupled to at least one of said first or second integrated circuit functional elements.

14. The computer system of claim 13 wherein said third integrated circuit functional element comprises a memory.

15. The computer system of claim 9 wherein said programmable array is reconfigurable as a processing element.

16. A processor module comprising:

at least a first integrated circuit functional element including a programmable array;

10 at least a second integrated circuit functional element including a processor stacked with and electrically coupled to said programmable array of said first integrated circuit functional element; and

15 at least a third integrated circuit functional element including a memory stacked with and electrically coupled to said programmable array and said processor of said first and second integrated circuit functional elements respectively.

17. The processor module of claim 16 wherein said programmable array of said first integrated circuit functional element comprises an FPGA.

18. The processor module of claim 16 wherein said processor of said second integrated circuit functional element comprises a microprocessor.

25 19. The processor module of claim 16 wherein said memory of said third integrated circuit functional element comprises a memory array.

20. The processor module of claim 16 wherein said programmable array is reconfigurable as a processing element.

21. The processor module of claim 16 wherein said first, second and third integrated circuit functional elements are electrically coupled by a number of contact points distributed throughout the surfaces of
5 said functional elements.

22. A programmable array module comprising:
at least a first integrated circuit functional element including a field programmable gate array; and
at least a second integrated circuit functional
10 element including a memory array stacked with and electrically coupled to said field programmable gate array of said first integrated circuit functional element.

23. The programmable array module of claim 22 wherein
15 said field programmable gate array is programmable as a processing element.

24. The programmable array module of claim 23 wherein said memory array is functional to accelerate reconfiguration of said field programmable gate array
20 as a processing element.

25. The programmable array module of claim 23 wherein said memory array is functional to accelerate external memory references to said processing element.

26. The programmable array module of claim 23 wherein
25 said memory array is functional as block memory for said processing element.

27. A reconfigurable processor module comprising:
at least a first integrated circuit functional element including a programmable array;

at least a second integrated circuit functional element including a processor stacked with and electrically coupled to said programmable array of said first integrated circuit functional element; and

5 at least a third integrated circuit functional element including a memory stacked with and electrically coupled to said programmable array and said processor of said first and second integrated circuit functional elements respectively

10 whereby said processor and said programmable array are operational to share data therebetween.

28. The reconfigurable processor module of claim 27 wherein said memory is operational to at least temporarily store said data.

15 29. The reconfigurable processor module of claim 27 wherein said programmable array of said first integrated circuit functional element comprises an FPGA.

20 30. The reconfigurable processor module of claim 27 wherein said processor of said second integrated circuit functional element comprises a microprocessor.

31. The reconfigurable processor module of claim 27 wherein said memory of said third integrated circuit functional element comprises a memory array.

25 32. A programmable array module comprising:
at least a first integrated circuit functional element including a field programmable gate array; and
at least a second integrated circuit functional element including a memory array stacked with and
30 electrically coupled to said field programmable gate array of said first integrated circuit functional

element, said first and second integrated circuit functional elements being coupled by a number of contact points distributed throughout the surfaces of said functional elements.

- 5 33. The programmable array module of claim 32 wherein said field programmable gate array is programmable as a processing element.

34. The programmable array module of claim 33 wherein said memory array is functional to accelerate
10 reconfiguration of said field programmable gate array as a processing element.

35. The programmable array module of claim 33 wherein said memory array is functional to accelerate external memory references to said processing element.

- 15 36. The programmable array module of claim 33 wherein said memory array is functional as block memory for said processing element.

37. The programmable array module of claim 32 wherein said contact points are further functional to provide
20 test stimulus from said field programmable gate array to said at least second integrated circuit functional element.

38. The programmable array module of claim 32 further comprising:

- 25 at least a third integrated circuit functional element stacked with and electrically coupled to at least one of said first or second integrated circuit functional elements.

39. The programmable array module of claim 38 wherein said third integrated circuit functional element includes another field programmable gate array.

40. The programmable array module of claim 38 wherein
5 said third integrated circuit functional element includes an I/O controller.

41. A method of fabricating a programmable array module comprising:

forming at least a first integrated circuit
10 functional element including a field programmable gate array and a plurality of metal pads on a base wafer;
forming a first epitaxial layer over the first integrated circuit functional element; and
forming at least a second integrated circuit
15 functional element including a memory array in the first epitaxial layer, the second integrated circuit functional element having a plurality of metal pads, at least one of which is in electrical contact with the metal pads of the first integrated circuit
20 functional element.

42. The method of claim 41 further comprising forming a first layer of silicon dioxide on the surface of the first integrated circuit functional element.

43. The method of claim 42 further comprising forming
25 the first epitaxial layer on the surface of the first silicon dioxide layer.

44. The method of claim 41 wherein forming the first epitaxial layer comprises forming a polysilicon layer.

45. The method of claim 41 further comprising etching
30 through the first epitaxial layer so that an

interconnection between the metal pads of the first and second integrated circuit functional elements can be subsequently formed.

46. The method of claim 45 further comprising etching
5 through a first silicon dioxide layer on the surface of the first integrated circuit functional element.

47. The method of claim 41 further comprising forming a second epitaxial layer over the first epitaxial layer such that a third functional element can be
10 integrated with the first two functional elements.

48. The method of claim 47 wherein forming the third functional element comprises forming an I/O controller, memory, FPGA, or microprocessor.

49. The method of claim 47 further comprising forming
15 a second silicon dioxide layer on the surface of the second epitaxial layer.

50. The method of claim 47 wherein forming the second epitaxial layer comprises forming a polysilicon layer.

51. A method of fabricating a processor module
20 comprising:

forming at least a first integrated circuit functional element such as a microprocessor on a base wafer; and

using wafer processing techniques, forming at
25 least a second integrated circuit functional element such as a field programmable gate array on the first integrated circuit functional element.

52. The method of claim 51 further comprising forming an electrical contact between at least one of a
30 plurality of metal pads associated with the first

integrated circuit functional element and at least one of a plurality of metal pads associated with the second integrated circuit functional element.

53. The method of claim 51 wherein forming the second
5 integrated circuit functional element comprises forming an epitaxial layer.

54. The method of claim 53 wherein forming the epitaxial layer comprises forming a polysilicon layer.

55. The method of claim 51 further comprising forming
10 a silicon dioxide layer on a top surface of the first integrated circuit functional element.

56. The method of claim 51 further comprising etching through the second integrated circuit functional element so that an electrical interconnection can be
15 established between the first and second integrated circuit functional elements.

57. The method of claim 51 further comprising forming a third functional element integrated with the first two functional elements using wafer processing
20 techniques.

58. The method of claim 57 wherein forming the third functional element comprises forming an epitaxial layer.

59. The method of claim 58 wherein forming the
25 epitaxial layer comprises forming a polysilicon layer.

60. The method of claim 57 wherein forming the third functional element comprises forming an I/O controller, memory, FPGA, or microprocessor.